Geophysical Research Abstracts, Vol. 7, 11079, 2005
SRef-ID: 1607-7962/gra/EGU05-A-11079

Oxygen isotopic profile across incipient charnockite – major minerals vs. zircon

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High grade metamorphic rocks occurring in the Eastern Segment of the Sveconorwegian orogen, SW Sweden are dominated by migmatised granitic gneisses which are locally charnockitised. At the Söndrum quarry, charnockite forms distinct ca. 2 m wide symmetrical margins to a ca. 0.5 m wide pegmatitic dyke. In some parts of the charnockite, a weak migmatitic structure is preserved, clearly indicating that charnockitisation overprints the migmatitic fabric. Newly formed zircons in the pegmatite and metamorphic zircon rims in the charnockite zone and surrounding gneisses are dated at 1397$\pm$4 Ma.

In this study we present oxygen isotope data from quartz, ilmenite and zircon separates, based on which, we may be able to distinguish between charnockite formation due to (1) melting-induced dehydration, whereby water is "sucked" from the charnockitising zone into a mobile melt phase (represented by the pegmatite) or (2) "flushing" of the gneiss by a CO_2 rich fluid. The analysed samples were collected in a continuous section through the pegmatite-charnockite contact and 27 cm into charnockite with a sample interval of 1 cm, and at intervals of 0.5 m, for a further 12 metres from the pegmatite. Quartz and ilmenite separates were analysed for oxygen isotopic composition using laser fluorination. Zircon samples were analysed by SIMS using the same sample that was used for geochronology.

We observed a small (ca. 0.2 per mille) increase in δ^{18}O of quartz separates in most of the charnockite zone relative to the surrounding gneiss and pegmatite however the highest value is just at the pegmatite-charnockite contact. Temperatures estimated from ilmenite-quartz fractionation are ca. 650 ^{o}C across the profile. However, much higher temperature estimates within the charnockite and pegmatite and lower temperatures within gneiss estimated by zircon-quartz fractionation might be indicative of disequilibrium.

Harris and Bickle (1989) studied the advective-diffusive transport of isotopic (δ^{13}C, δ^{18}O) and charnockitisation fronts, which they interpret to result from infiltration of a CO_2 bearing fluid. Based on their results, we calculated that the expected advective displacement of the δ^{18}O front at Söndrum for the CO_2-“flushing” model was ca. 6 cm away from the pegmatite. No such front was observed.

We therefore used available isotopic fractionation data to generate a model oxygen isotope profile for the melting-induced dehydration. Here, we assume that fluids are lost from the charnockite, “sucked” into the pegmatite. This model more closely replicated our quartz data.

Harris, N.B.W. and Blink, M.J., Earth and Planetary Science Letters, 93 (1989) 151-156.